Phantom Pain Aid Comes from Unlikely Origin

Sometimes remedies for complex problems come from unex-pected sources. Katherine Bomkamp is a college political science major whose career goal is to become a corporate attorney. But, oh by the way, she is also developing a potentially breakthrough solution to the wide-spread amputee phenomenon known as phantom limb pain. Though originally thought to have psychological roots, phantom pain is now understood to be a result of the brain continuing to send signals and commands to a limb no longer present. An estimated 80 percent of the world’s 10 million amputees experience this sensation to some degree.

While still in high school, Bomkamp met various military amputees while accompanying her father, a disabled Air Force veteran, on lengthy appointments at the former Walter Reed Army Medical Center. Upon hearing their lingering issues with phantom pain and simultaneously seeing a project for her school’s International Science and Engineering Fair, she set out to develop an alternative solution to the powerful and addictive medications often prescribed.

After interviewing various phantom pain authorities, Bomkamp devised a concept based on thermal biofeedback, in which concentrated, controlled heat applied to severed nerve endings in the residual limb would induce the brain to focus on the heat instead of sending signals to a limb no longer present. (A side benefit is that the heat also relaxes residual limb muscles.)

When her idea sparked initial acceptance, the young student decided to run with it. She engaged a prosthetic consultant to provide professional expertise and build the first prototype of what became known as the Pain-Free Socket. The product consists of thermo-resistive wiring connected to a battery pack incorporated in a below-knee prosthetic socket. After several generations of development, the device is now awaiting patent approval.

Meanwhile, Bomkamp has written a business plan, formed a company (of which she is CEO) to bring the concept to market, and been inducted into the National Gallery for America’s Young Inventors. She hopes to bring the Pain-Free Socket into a limited clinical trial in 2014. Quite a start for a college senior who just turned 22!

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O&P Trends & Developments

A publication of Leimkuhler Orthotic & Prosthetic Center Inc.

You Can See the Future from Here!

For most of the last year, news about the health care industry has been dominated by insurance and reimbursement issues, notably so in our orthotics and prosthetics (O&P) specialty. From the halting imple-mentation of the Affordable Care Act to unprecedented limitations on Medicare funding for more-than-basic O&P componentry, media attention in our field has been much more focused on financial problem-solving than advances in the rehabilitative care we provide. That’s unfortunate, for we are on the verge of some remarkable breakthroughs in O&P technology that can markedly improve lifestyle horizons for different populations of physically challenged patients...some in the near future.

C-Brace ——————————
prototype.

O&P Tomorrow

The new C-Brace® KAFO (knee-ankle-foot orthosis) applies much of the same advanced technology used in the ground-breaking C-Leg® prosthetic limb to the needs of patients contending with lower-limb dysfunction, notably partial paralysis, post-stroke issues, spinal cord injury and post-polio syndrome. It is the first orthosis to prove both swing- and stance-phase support through hydraulic control of the knee joint. Like its prosthetics predecessor, the C-Brace utilizes electronic sensors and microprocessors to perform real-time gait analysis and hydraulic systems to provide the correct knee response for safe, energy-efficient ambulation. By continually sensing movements of the patient’s knee and ankle, the C-Brace is able to deliver immediate compensatory reactions to enable the wearer to proceed confidently throughout the gait cycle, climb and descend stairs, and change walking speed on all types of terrain.

Key features include:
• Stance phase control - Resistance to uncontrolled knee flexion when sensors detect a moment of instability gives the wearer the ability and time necessary to recover and avoid a fall.
• Real-time gait analysis – Each segment in the gait cycle is controlled dynamically and in real time, allowing the patient to walk with greater ease, reduced concentration and considerably less compensation of their side and torso...and therefore less fatigue.
• Stance and second mode – Selectable modes

C-Brace: A Leap Forward in KAFO Design

Currens One-Back Health Care

The Father of 3-Track Skiing

Winter is snow season and a fitting time to remember the founder of our practice, the late Paul E. Leimkuhler, a true pio-neer of disabled skiing. Paul, a gifted athlete, was a former Ohio state cycling champion and an uncontrolled skier who in 1944, as an Army 2nd lieutenant at the Battle of the Bulge he sustained injuries resulting in the amputation of his left leg above the knee. Undeterred, he fought to regain his active lifestyle upon his return home and in time found his way to the ski slopes, using a single ski on his “good” leg and two hand-held outrigger ski crutches of his own design. Fascinated by a Euro-pen film featuring amputee skiers, Paul developed his outriggers by stopping the film and making mea-surements on the screen.

For that reason, we are devoting this issue of our newsletter to a preview of some of the most exciting projects currently under development. We hope you find the coverage interest-ing and worthwhile.
It’s Coming: The Portable Power-Assisted Ankle-Foot Orthosis

Paul E. Leimkuehler

(Continued from page 1)

He and a fellow amputee skier soon became known across the country for their prowess with the outriggers and willingly shared their concept with other amputees. Soon amputees as far away as California were learning to ski using Paul’s method, and by the late-1960s he was helping the founders of the National Handicapped Ski Races develop disabled programs at several resorts.

For his drive, skill and innovation, Paul Leimkuehler was presented the 1990 Disabled Ski Hall of Fame Award for Individual Contribution to Development. He is one of 31 inductees to date voted into the Hall.

His citation notes that while his development of the first outriggers was a milestone in disabled skiing, it was Paul’s efforts in teaching others how to use the equipment he developed that demonstrated his caring and dedication to the sport.

The National Disabled Ski Hall of Fame was created in 1995 by the Disabled Sports USA and the National Sports Center for the Disabled to honor individuals who have had an influential role in disabled sports as well as athletes who have excelled in disabled sports.

The hall consists of famed pictures and biographies of the inductees, as well as a display of equipment used for skiing. It opened in 2006 at the U.S. Olympic Training Center in Park City, Utah.

Someday in the not-too-distant future, individuals with significant lower-limb motor impairment will ambulate successfully and efficiently aided by a power-assisted ankle-foot orthosis using a compact, portable source of fluid (pneumatic or hydraulic) energy.

That development will open new lifestyle options to a population limited by impeded ankle function secondary to stroke, trauma, incomplete spinal cord injury, cerebral palsy, poly, muscular dystrophy, and multiple sclerosis, among others.

Such a device could be applied in daily use to enhance walking function and as a physical therapy tool for gait training and building strength and range of motion.

Normal dorsiflexion and plantarflexion muscle groups. Traditional AFO designs, controlling predominantly of fixed or articulated passive devices providing motion control and joint stability only, often fail to restore normal ankle function because they are incapable of generating any sort of propulsion assist. Unlike current functional electrical stimulation units, which induce the peroneal nerve to activate the dorsiflexors but generate no plantarflexion help, a power-assisted AFO would provide both.

The first step toward a powered orthosis occurred in various laboratories using external power sources to generate torque assistance at the ankle. While these “tethered” prototypes are valuable for laboratory research and clinical-based therapy, they do not enable the wearer to function independently in the outside world.

Since 2006, a multi-disciplinary team fund- ed by a National Science Foundation grant and operating from several major U.S. institu- tions, has been working on a portable powered ankle-foot orthosis (PPAFO), which initially can serve as a rehabilitation aid, both in clinical setting and as a take-home-device and longer-term as an effective daily-wear assist.

To reach that goal, the team must overcome two key design challenges:

1. The system requires a compact, lightweight, high-efficiency power source and actuator capable of providing alternating dorsiflexion and plantarflexion assistance for an extended period.

2. The orthosis must incorporate sensors capable of recognizing different gait modes (ambulating on level ground, stairs, ramps, etc.) and a control system that can react promptly to mode changes.

The early generation prototype incorporates a bidirectional pneumatic actuator powered by compressed gas from paintball-styled CO2 canisters worn on a belt. Researchers hope project future iterations will be actuated by hydraulic or pneumatic power generated by a minute engine contained within the PPAFO profile.

In operation the PPAFO assists the wearer through the critical stages of the gait cycle. It provides a dorsiflexion moment to control foot-off at heel strike to prevent foot slap, permits free ankle plantarflexion up to mid-stance, and generates plantarflexion torque at terminal-stance for propulsion and dorsiflexion assist during swing to prevent foot drop.

Early applications of the PPAFO prototype have been encouraging. Results appear in the Journal of Rehabilitation Research and Development, Vol. 48, No. 4, 2011. (Scan QR code at right to access.)

Clinical Study to Assess Efficacy of Fat Grafting For Residual Limb Pain

A long-standing challenge for prosthetists and amputees is a bony or irregularly shaped residual limb, which lacks sufficient soft tissue to provide padding over bones resulting in an uncomfortable and cosmetic deformity.

A uneven residual limb surface not only makes a total contact vacuum seal between anatomical and mechanical surfaces difficult but also provides a source of painful irritation and skin wounds, often leading to a poor prosthetic outcome.

Various methods and products have been employed over the years to address this problem, but a reliable solution remains elusive.

Now, a new approach involving fat grafting is being investigated at the University of Pittsburgh Medical Center. Active duty military personnel age 18 and above who have undergone a limb amputation with subsequent pain that limits fitting and use of a prosthesis are being sought to participate in clinical trials at the UPMC Center for Innovation in Restorative Medicine.

Minimally invasive fat grafting is nothing new—plastic surgeons have performed over 65,000 such procedures in 2011, removing fat from parts of the body where it is unwanted, or less-needed, and replacing it in a more desirable location to replication lost shape or fullness. In this experimental prosthetic application, that location would be the residual limb to provide additional subcutaneous tissue padding over bony prominences and peripheral nerve trunks.

But there’s a problem: Fat has little structure or volume, which makes productive grafting into a residual limb particu- larly challenging. However, UPMC researchers believe they can overcome this issue by stripping the collected fat down to only the dense, stem cell-rich component and injecting that refined fat into residual limbs.

Stem cell-rich fat promotes blood vessel growth and blood flow, volume, and lift, crucial factors for the survival of the fat graft and promoting healing and stability.

The study is scheduled for completion in May 2015.

Note to Our Readers

Mention of specific products in our newsletter neither constitutes endorsement nor implies that we will recommend selection of those particular products for use with any partic- ular patient or application. We offer this information to enhance professional and individual understanding of the orthotic and prosthetic disciplines and the experience and capabilities of our practice.

We gratefully acknowledge the assistance of the National Disabled Ski Hall of Fame and Otto Bock Healthcare in compiling this issue.
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Portable powered AFO; see page 2.

Winter 2014

The Father of 3-Track Skiing

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